alberta canada

ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

SECOND ANNUAL REPORT

1976-77

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The Alberta Oil Sands Environmental Research Program was established in 1975 by agreement between the Ministers of the Environment for Alberta and Canada.

It is a multidisciplinary research program involving scientific research expertise from both the governments of Alberta and Canada, Alberta universities and private industry, with a mandate to investigate the possible effects of development in the Athabasca oil sands upon the renewable resources of the natural environment.

Additional copies of this Second Annual Report of the Alberta Oil Sands Environmental Research Program are available upon request to

AOSERP
9820 - 106 Street
Edmonton, Alberta T5K 2J6
(403) 427-3943

AOSERP Report 21

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LETTER OF TRANSMITTAL

The Hon. David J. Russell
Minister of the Environment
Legislative Building
Edmonton, Alberta.

and

The Hon. Romeo LeBlanc
Minister of Fisheries and the Environment
Parliament Buildings
Ottawa, Ontario.

Sirs:

Enclosed herein is the Second Annual Report of the Alberta Oil Sands Environmental Research Program, for the year 1 April 1976 to 31 March 1977.

This document consists of concise summaries of the research conducted under the auspices of the Program in its second year of operation, under the Alberta-Canada Agreement of February 1975.

Most respectfully,

W. Solodzuk, P.Eng.
Chairman, Steering Committee, AOSERP
Deputy Minister, Alberta Environment

J. S. Tener, Ph.D.
Member, Steering Committee, AOSERP
Assistant Deputy Minister
Environmental Management Service
Fisheries and the Environment Canada.

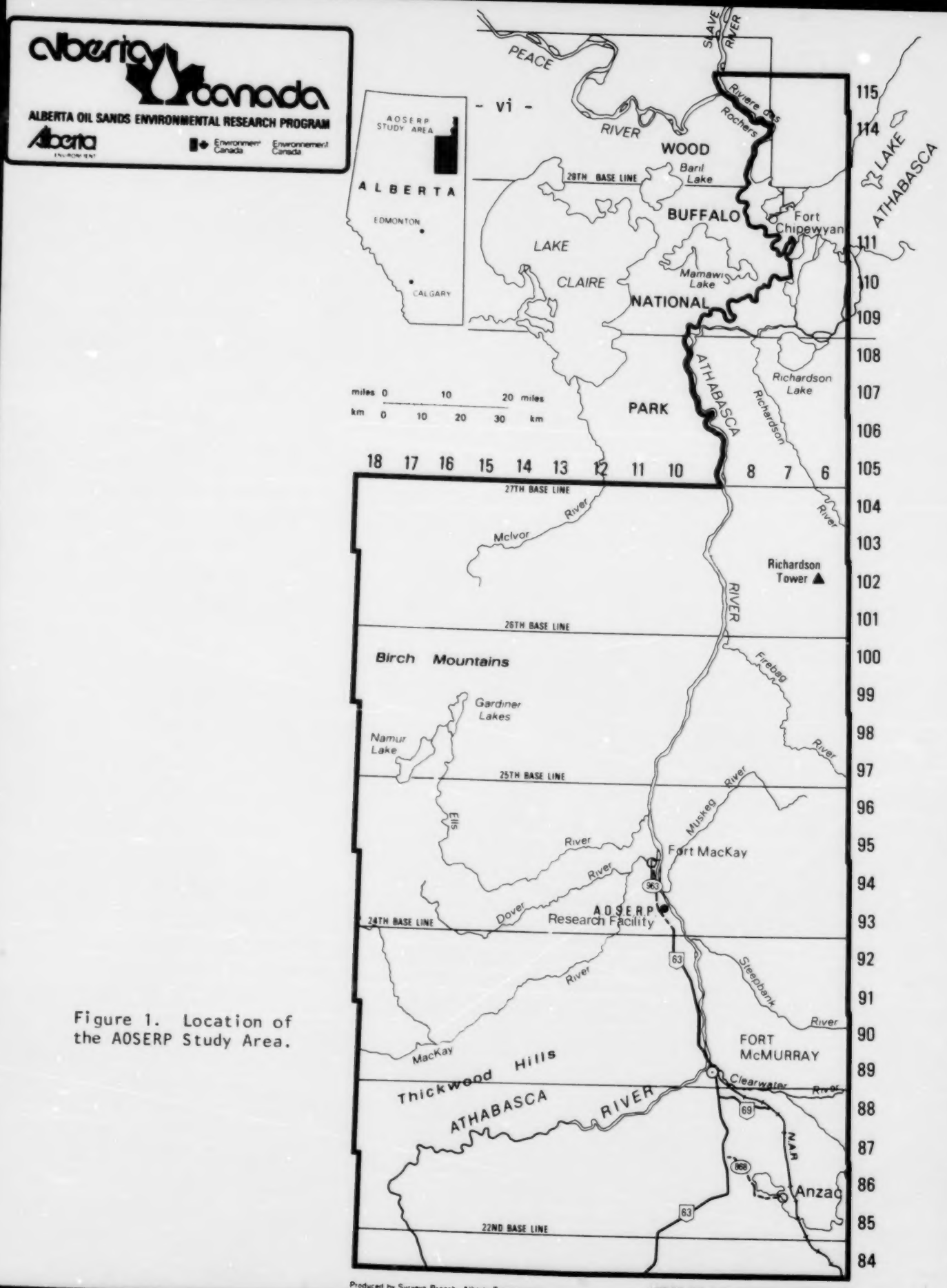

Figure 1. Location of the AOSERP Study Area.

MESSAGE FROM THE STEERING COMMITTEE CHAIRMAN

The second year of this important Program has enabled researchers to accumulate a full year's record on the environment of the Athabasca oil sands area. This information plus the accumulated data of future years, and its interpretation and application by government and industry, will enable a balance between resource development, environmental protection, and quality of life during and after the development of the oil sands.

The governments of Alberta and Canada are committed to the principle that findings of the Program will be vital in predicting the effects of existing and future developments, and have redemonstrated that commitment by their strong funding support and personal interest of the Ministers during this second year.

The Steering Committee held monthly meetings during the year in providing policy level direction to the Program.

During the course of the year, it became apparent that the committee structure for Program design and research management that served so well in defining the initial areas requiring research was not the optimum structure for effective integration and coordination of the ongoing research effort. With the help of the Advisory Committee on Program Coordination and a special task force composed of a senior manager from each of Alberta and Canada and the Program Director, a reorganized structure and amended agreement were presented to the Alberta and Federal Ministers. The Ministers have agreed in principle to the required changes which will be fully implemented in the coming year.

As a new Chairman of the Steering Committee, I have been impressed by the breadth and depth of the Program, the dedication of its researchers, and its obvious potential for assisting in the development of the oil sands with due regard for the environment and the quality of life.

W. Solodzuk, P.Eng.
Chairman, Steering Committee, AOSERP

REPORT OF THE PROGRAM DIRECTOR

The Alberta Oil Sands Environmental Research Program has continued with its task of environmental research relative to the renewable resources of the Athabasca oil sands area. The Program is making information available to government and industry to ensure an acceptable quality of the environment during and after operations for the recovery, transport, and processing of oil sands products. This research is directed to the solution of practical social and technical environmental problems resulting from oil sands development. Thus the Program will provide scientific data to enable governments and industry to do a better job in the management of the area as it develops by meeting the standards and services required for legislation such as: The Clean Air Act, The Clean Water Act, The Migratory Birds Convention Act (Canada), The Wildlife Act, The Fisheries Act (Canada), The Forests Act, The Land Surface Reclamation and Conservation Act, and other statutes.

Within a study area of roughly seven million acres centered on the Athabasca oil sands deposit, the Program has responsibility for designing, funding, implementing and coordinating the research efforts of eight Technical Research Committees in the areas of Aquatic Fauna, Human Environment, Hydrology, Hydrogeology, Land Use and Reclamation, Meteorology and Air Quality, Terrestrial Fauna, and Vegetation.

The research plan of the Program has had three distinct thrusts: First, within the first two or three years to gain an understanding of the baseline environmental conditions of the areas directly and indirectly affected by oil sands development such as the surface mining area and the Athabasca River and its Delta.

Secondly, research has been initiated on those problem or site-specific areas that were identified as requiring investigation such as the selection of plant species suitable for revegetation of mined-out areas.

The third approach concentrates research in several disciplines into watershed or regional areas so that an integrated capability is developed to anticipate and contend with the impacts of oil sands development.

Much of the work conducted in the first year was capital intensive, involving the construction of a field research facility, water gauging stations

and meteorological towers. The remainder of the monitoring networks for studying climatology, air quality, water quality and water quantity were completed during 1976-77. Additional required services were added to the Mildred Lake Research Facility in the form of increased laboratory units and equipment, maintenance and storage areas. The monitoring networks formed a central part of the 69 major research efforts funded during 1976-77 so that the data accumulated over several full seasons of record can be applied by the research scientists to their particular work.

As in the first year of AOSERP's operation, $4,500,000 was allocated by the two governments, with Alberta contributing $2,500,000 and Canada $2,000,000. Of the amount budgetted, about $3,900,000 was expended, with $600,000 being returned to general revenue.

The Program is committed to publishing research findings as soon as a project is completed, or in the case of most of the work which is long term in nature, interim reports are published at appropriate intervals. At year end, seven final reports have been published and another thirteen are in print. As the Program proceeds, the frequency of reporting will increase.

The sheer size, the broad and comprehensive nature of the Program have required the skills, dedication, and patience of a great many people to initiate and sustain the research effort reported here. Appreciation is expressed to the many who have supported and assisted our tasks; a confident optimism thus endures for future Program achievements.

Milt G. Pahl
Program Director

TECHNICAL RESEARCH COMMITTEES
ACTIVITIES FOR 1976-77

AQUATIC FAUNA TECHNICAL RESEARCH COMMITTEE

HUMAN ENVIRONMENT TECHNICAL RESEARCH COMMITTEE

HYDROGEOLOGY TECHNICAL RESEARCH COMMITTEE

HYDROLOGY TECHNICAL RESEARCH COMMITTEE

LAND USE TECHNICAL RESEARCH COMMITTEE

METEOROLOGY AND AIR QUALITY TECHNICAL RESEARCH COMMITTEE

TERRESTRIAL FAUNA TECHNICAL RESEARCH COMMITTEE

VEGETATION TECHNICAL RESEARCH COMMITTEE

AQUATIC FAUNA TECHNICAL RESEARCH COMMITTEE
RESEARCH ACTIVITIES, 1976-77

During 1976-77 Aquatic Fauna research proceeded along four main lines. In broad terms these were: toxicology, lake acidification - heavy metal cycling, fisheries, and invertebrates. Within the AOSERP study area, special emphasis was placed on the Muskeg River basin for intensive studies on fish and aquatic invertebrates. The goal of the work was to provide management and regulatory agencies with indications of the types of aquatic resources of the Athabasca oil sands region and an estimation of their importance to the Athabasca River system. Some attention was paid to the effects of specific development activities.

Toxicology studies focused on one major wastewater (mine depressurization water) in terms of lethal and sub-lethal effects. Experiments were carried out in the field (Fort McMurray) as well as in the laboratory (Winnipeg). Additional laboratory studies were carried out on specific components of oil sands development wastewaters (vanadium, nickel and phenol).

Acidification of waterbodies is of major concern where quantities of sulphur dioxide are released to the atmosphere. During 1976-77 studies were commenced at the Experimental Lakes Area near Kenora, Ontario to determine the effects of acidification and to determine if heavy metals deposited in lakes or mobilized from sediments are toxic to fishes or their food organisms. A coincident study was carried out in the AOSERP study area to determine the acidification potential of lakes in the oil sands region of northeastern Alberta.

Fisheries studies were initiated in the Athabasca and the Muskeg River basins. The Athabasca River study was to assess the fish population of the Athabasca River within the AOSERP study area as related to the Athabasca River system. An intensive study on the Muskeg River was to provide quantitative information on the fish of this basin as related to the Athabasca. In addition, the recreational fishery of the region was studied through a cooperative effort with the Terrestrial Fauna sector.

Aquatic invertebrate studies were concentrated on the Muskeg River drainage with limited surveys on the MacKay, Steepbank, Poplar and Beaver drainages as well as the Athabasca River delta. The objective of these studies is to conduct a regional inventory of the aquatic invertebrate species, evaluate the production of watersheds and conduct manipulation experiments with various types of pollutants on benthic communities. Experiments have included the effects of natural contamination from the oil sands deposits as well as the oil sands extraction products and wastes.

Information pertaining to the nature, scope and status of Aquatic Fauna projects is outlined in the following descriptions and status reports.

SUB-PROJECT TITLE
AND DESCRIPTION: AF 1.1.2 Acute Toxicity Bioassays of Liquid Oil Sands Wastewaters

The purpose of this project is to provide information regarding the acute lethality of oil sands mining and extraction plant wastewaters to fish. Specific objectives for work in 1976-77 were to provide toxicity information on a specific wastewater using Athabasca River water as the diluent and to compare the value of field toxicity studies and the predictive accuracy of laboratory bioassays using treated waters rather than natural waters.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Environment, Pollution Control Division; Mr. W. Lake

STATUS REPORT:

Acute lethality bioassays were conducted using mine depressurization water as the liquid wastewater and Athabasca River water as the acclimation and dilution water. The bioassays were carried out at a mobile laboratory established in Fort McMurray for the testing period.

Mine depressurization water was collected from five wells on Syncrude's Lease 17. Ninety-six hour semi-static bioassays were performed on individual wells and composites using trout-perch seined from the Athabasca River. Continuous flow bioassays were conducted on a composite sample using rainbow trout as the test species to determine the effect of storage time in toxicity. All of the bioassays performed indicated that mine depressurization waters are acutely toxic to trout perch and rainbow trout.

There is no plan to continue this sub-project beyond March 1977 as an acute lethality inventory of existing oil sands mining and extraction plant wastewaters has been completed. A final report on this sub-project will be completed by May 1977.

SUB-PROJECT TITLE
AND DESCRIPTION: AF 2.0 Aquatic Invertebrates

This project is to describe the basic ecology of aquatic benthic macrofauna of the Athabasca River, its delta and tributaries within the AOSERP study area. Such basic taxonomic and life cycle data are required in support of future manipulative and experimental studies designed to accurately describe and predict changes in benthic communities which can be expected from oil sands development activities.

The specific objective for 1976-77 was to study the benthic ecology including species and community compositions of aquatic macroinvertebrates of the Muskeg and Steepbank rivers.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Fisheries and Marine Service;
Drs. R. Wallace and D. Barton

STATUS REPORT:

In 1976-77 major efforts were concentrated on the lower Muskeg and Steepbank rivers. Benthic invertebrates were collected at sites near the mouth of each stream at approximately weekly intervals to assess the taxonomic composition of the fauna as well as the relative abundance of various groups. General qualitative surveys of both watersheds were conducted in July and October 1976 and in January 1977. Organisms also were collected at irregular intervals from the Athabasca River and several tributary streams. Nearly 200 invertebrate taxa have been recognized so far, many of which represent extensions of previously known distribution ranges.

Exploratory studies of the effects of synthetic crude oil and tailings pond sludge on benthic communities were conducted in the lower reaches of the Muskeg River. Preliminary results suggest that tailings pond sludge, even at very low concentrations, severely reduces the standing stocks of benthic macroinvertebrates, especially the larger insect species. Synthetic crude oil, on the other hand, appears to encourage the development of dense populations of some chironomid species. An interim report on 1976-77 research activities will be completed by September 1977.

SUB-PROJECT TITLE
AND DESCRIPTION: AF 2.3.1 Studies on Lake Acidification and Cycling of Heavy Metals in Aquatic Ecosystem

The purpose of this research project is to study the effects of acidifying a small soft-water lake on biogeochemistry of the lake ecosystem. Specific objectives are to determine if acid fallout lowers the overall productivity of lakes by decreasing their dissolved inorganic carbon content; if acidification directly alters the physiology of fishes, their eggs or fry; if heavy metals deposited in the lakes or mobilized from sediments are toxic to fishes or their food organisms.

The above objectives are being addressed in a whole-lake experiment, supplemented with large tubes experiments, at the Experimental Lakes Area in northwestern Ontario. Acidification of the whole-lake is being done through the addition of sulphuric acid to achieve a reduction of the pH by 0.5 units per year for five years.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Fisheries and Marine Service;
Dr. D.W. Schindler

STATUS REPORT:

The interim report on 1976-77 research activities has been received. In this report, data on the chemistry and biology for the experimental lake are presented for two background years and for 1976 when sulphuric acid was added to the lake. The only observable chemical effect during the first year of the study was a halving of the dissolved organic carbon concentration. Short-term effects on the biota were not observable. Mass-balance calculations allowed identification of two possible mechanisms in addition to dissolved bicarbonate which might buffer the lake system: lake sediments and dissolved colloids. Similar experiments carried out in large tubes (limnocorrals) revealed that some trace metals were mobilized from sediments as the pH dropped while others did not appear to change.

Acidification continues.

SUB-PROJECT TITLE
AND DESCRIPTION: AF 2.5.1 Ecology and Life Cycles of Aquatic Invertebrates in Hartley Creek

The project is designed to provide detailed information on the ecology and community structure of benthic invertebrates in Hartley Creek, a tributary to the Muskeg River. It is to provide baseline information on the principal invertebrates in the stream as well as their interrelationships with each other and their physical-chemical environment.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Environment. Dr. R. Hartland-Rowe and Dr. R. Davies, University of Calgary

STATUS REPORT:

An interim report on the first year research activities of this two-year study has been received. The report indicates that benthic invertebrate fauna of Hartley Creek are rich and diverse. Chironomidae larvae predominate, both in numbers and biomass, with Trichoptera being the second most abundant group. Other abundant groups are Ephemeroptera and Plecoptera.

The life-cycles of those species which have been examined are broadly typical of those found elsewhere in North America, frequently modified by a delayed adult emergence period. Many of the species present are eastern Canadian in their affinities and represent westward extensions of their known ranges.

SUB-PROJECT TITLE
AND DESCRIPTION: AF 3.2.1 Aquatic Environmental Toxicology Research Studies

In order to detect the subtle as well as gross effects produced by oil sands contaminants in aquatic organisms, it was deemed important to establish a broad toxicological screening system using different organisms, responses and life-stages. The objective of the research project was to provide a sequence of toxicity testing applicable to use for on-site testing and a basis for future evaluations of field fish. Results from the laboratory studies should guide the field observer in areas of fish distribution, histological and biochemical lesions, growth and reproduction.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Fisheries and Marine Service; Drs. J. Klaverkamp and M. Giles

STATUS REPORT:

During the year emphasis was placed on evaluating mine depressurization water and heavy metals (copper and vanadium). Bioassays were conducted on mine depressurization water to determine acute lethality to fish and invertebrates, avoidance/preference reactions using fish and invertebrates, sub-lethal effects on invertebrates and histopathology on gill, liver, and kidney tissues from rainbow trout.

Toxic component studies were performed to determine the effects of pH on toxicity, avoidance/preference, cardiovascular/respiratory, liver and kidney enzymes, histopathology and invertebrate toxicity.

A final report on the project is to be completed early in the 1977-78 fiscal year.

SUB-PROJECT TITLE
AND DESCRIPTION: AF 3.5.1 Acute and Chronic Toxicity of Vanadium to Fish

The acute toxicity component of the project is designed to obtain firm numbers on vanadium lethality to allow an assessment of danger in comparison to other pollutants; to obtain a quick measure of toxicity in all types of water likely to be encountered; and to point out any pecularities of vanadium effects. Chronic experiments are designed to detect any long-term or sublethal effects which might affect fisheries production. One generation experiments with fish should show any such effect whether it results from bioaccumulation, chronic morbidity, reproduction, growth or other modes of action.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Fisheries and Marine Service;
Dr. J. Sprague, University of Guelph

STATUS REPORT:

Most of the work during the 1976-77 fiscal year focused on the determination of an experimental design to reflect the toxicity of the different forms of vanadium at different water hardnesses and on resolving the aqueous chemistry of vanadium. Vanadium pentoxide dissolves in Guelph well-water within one day and remains in samples for at least two weeks. The V^{+5} valence state predominates under natural water conditions and can be measured titrimetrically at the 5 to 15 mg/ℓ range likely to be of interest in acute lethality tests. Theoretical considerations indicate that ortho-, meta-, and decavanadates are the forms of vandium likely to be encountered during acute and chronic testing, with two forms of orthovanadate ($4VO_4$ = and H_2VO_4-) predominating below 5 mg/ℓ. These forms occur at different pH ranges and initial toxicity testing took place to determine if they differed in toxicity.

Work on the project will be completed by August 1977 with a final report expected during September 1977. The report will provide the thresholds for acute and chronic toxicity of vanadium to fish. This will allow AOSERP to determine whether or not a problem exists with vanadium in the effluents and emissions from oil sands development activities.

SUB-PROJECT TITLE
AND DESCRIPTION: AF 3.6.1 Multiple Toxicity of Nickel, Vanadium and Phenol to Fish

This project is to provide a comprehensive and demonstrative rationale for formulating water quality criteria to safeguard aquatic organisms from mixtures of nickel, vanadium and an organic (phenol) in wastewaters. Aspects of the lethal and sublethal toxicity of each toxicant are being studied. Results will be evaluated to determine the predictability of the relative toxicity of their mixtures. Furthermore, the experiments are designed to demonstrate whether or not the mechanisms of lethal toxicity to certain mixtures are correlated with their respective sublethal actions.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Fisheries and Marine Service;
Dr. P. Anderson, Concordia University

STATUS REPORT:

Considerable attention was paid to designing appropriate experimental apparatus during the initial phase of the study. To simulate the most likely solutes of vanadium upon its fallout as vanadium pentoxide from oil refinery flyash, a unique source system was devised, which delivers a leachate of vanadium pentoxide to a continuous-flow bioassay apparatus. Preliminary bioassay experiments have been carried out using this apparatus to obtain lethal response curves for rainbow trout exposed to pure solutions of vanadium and nickel. In addition, work was carried out to determine levels of nickel in rainbow trout tissues exposed to experimentally high levels of nickel in the water and/or food.

Work on the project will be completed in 1977 with a final report due by year end.

SUB-PROJECT TITLE
AND DESCRIPTION: AF 4.2.2 Field Testing of Surgically Implanted Radio Tags in Fish

The project was undertaken during 1976-77 to implant radio tags in walleye, goldeye, northern pike and observe reactions, to test radio tags and interrogation in a lake and a river; to test interrogation of radio tags from an aircraft; and to generally test the feasibility of using radio tags under field conditions in the AOSERP study area.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Recreation, Parks and Wildlife, Fish and Wildlife Division; Mr. H. A. Baldwin and Dr. B. Bidgood

STATUS REPORT:

A final report on the project has been submitted. A radio tag system design has been completed and tested in the laboratory. Surgical implant procedures have been investigated and developed. Acceptance of the radio tag capsule by four species of fish has been examined and preliminary field tests with radio-implanted fish were undertaken.

In the future, receiver design, data processing and field operating and tracking procedures will be funded by Alberta Recreation, Parks and Wildlife, Fish and Wildlife Division.

SUB-PROJECT TITLE
AND DESCRIPTION: AF 4.3.2 Biological Sampling and Tagging of the Major Fish Species of the Athabasca River

The purpose of this project is to assess the baseline states of the fish resources of the Athabasca River downstream from Fort McMurray. Through a systematic field sampling program the fish populations are described in terms of their relative and seasonal abundance. Information is collected relative to the life history and general biology of the various fish. Species migration routes and timing for major fish species are being determined through a conventional tagging program.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Recreation, Parks and Wildlife, Fish and Wildlife Division; Mr. D. K. Berry

STATUS REPORT:

In 1976, work was confined to the 80 mile reach between Fort McMurray and the Firebag River. In this area the fish populations were sampled using variable mesh gill nets, large and small mesh seines, angling gear and electrofishing apparatus. Floy tags were applied to approximately 2500 fish. Recapture of tagged fish will permit delineation of migration routes.

Results indicate the presence of 25 fish species within the study area. Major spawning migrations of walleye, longnose sucker and white sucker were found to occur in April and May. Goldeye were abundant throughout the summer. A large spawning run of lake whitefish entered the study area in August and continued into October. Preliminary tag returns indicate some movement of suckers and walleyes between the study area and Lake Athabasca. Trout, perch and emerald shiners were the most abundant forage species.

An interim report on 1976-77 activities has been submitted for publication.

SUB-PROJECT TITLE
AND DESCRIPTION: AF 4.5.1 Intensive Study of the Fish Fauna of the Muskeg River Watershed

This project is part of a longer term study intended to describe the baseline states of the fish resources of major tributary streams in the AOSERP study area and to provide a quantitative estimate of the significance of these watersheds in terms of the fisheries to the Athabasca River system. During 1976-77 the Muskeg River watershed was studied intensively.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Fisheries and Marine Service; Mr. W. A. Bond

STATUS REPORT:

In 1976 the main emphasis for this project concerned the establishment of a two-way fish counting fence on the lower Muskeg River, one kilometer upstream from its confluence with the Athabasca River. The fence enabled the monitoring and quantification of fish movements into and out of the watershed. Major upstream movements of white and longnose suckers as well as a migration of Arctic grayling were documented in late April and early May. Floy tags were applied to more than 2000 migrants, the recapture of which will permit a description of migration routes within the Athabasca River system. The use of small mesh seines permitted a preliminary evaluation of the resident fish populations of the Muskeg River watershed in terms of species composition and distribution as well as helping to delineate that portion of the watershed utilized by migrant populations.

The project will be continued into 1978 and will conclude in a final report during that year.

HUMAN ENVIRONMENT TECHNICAL RESEARCH COMMITTEE
RESEARCH ACTIVITIES, 1976-77

Activities of the Human Environment Technical Research Committee during 1976-77, were divided into two phases:

1) overall assessment of the state of knowledge on social change in resource communities, and

2) exploratory assessment of the current social conditions and processes in the Athabasca oil sands region.

The purpose was to develop an appropriate research methodology for the study of social impacts.

The first phase featured continuation of research established in 1975-76, including feasibility studies regarding a traditional baseline data system, a theoretical social indicator model, and a research design for study of social problems in the region. These studies determined that little is known about resource communities in general, that baseline data for the AOSERP area are not adequate and their present quality and form hamper their utilization, and that exploratory field studies need to be conducted before an appropriate research methodology is selected.

The second phase featured two types of research: literature based exploratory studies pertaining to family and individual adjustment and social deviance in the region; and community field studies relying on "participant observation" technique, which attempted to determine what social problems do the local people perceive to be associated with the oil sands development.

Both the literature based research and the community field studies encompassed four general research questions:

1. What is happening to people in the oil sands region?

2. Why is it happening?

3. Is it positive or negative?

4. What can be done about it?

While answers to these questions will not be found until much later, the studies did help to clarify that if the Human Environment research is to identify and critically assess the social impacts associated with oil sands development, it should rely on a quantitative longitudinal methodology. The longitudinal research method will thus be incorporated in future Human Environment studies.

SUB-PROJECT TITLE
AND DESCRIPTION: HE 1.1.1 Structure of a Traditional Baseline Data System

This study was to determine whether appropriate data exist for development of a comprehensive statistical baseline data system for the Athabasca oil sands region. The objectives included: a review and assessment of data; evaluation of weaknesses and deficiencies in existing data sources; development of recommendations based upon the foregoing evaluation; and development of a bibliography.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Business Development and Tourism, Northern Development Branch; Dr. W. W. McVey, Population Research Laboratory, University of Alberta

STATUS REPORT:

The study began in December 1975; the report was completed in July 1976 and published in December, 1976. It was found that while a baseline data system can be developed given the present status of data and statistical areas, its utilization would be hampered by the unevenness of data availability and lack of common boundaries among data collecting agencies.

SUB-PROJECT TITLE
AND DESCRIPTION: HE 1.1.2 Feasibility Study Leading to the Development of a Theoretical Indicator Research Model for the AOSERP Project Area

The purpose was to assess the feasibility of a social indicator research model which could be applied to analysis and forecasting of quality of life in the Athabasca oil sands region. The research was to establish if such a model is applicable and appropriate to the region.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Business Development and Tourism, Northern Development Branch; Dr. Earle L. Snider, Urban Research Consulting Ltd.

STATUS REPORT:

The study began in February 1976 and was completed in June 1976. The report consists of a general review of literature on social indicators and of a review of some past attempts to operationalize social indicators research. It was decided to postpone the attempts to develop a social indicators research model because of the methodological problems involved and the problems connected with data incompatibility.

SUB-PROJECT TITLE
AND DESCRIPTION: HE 1.2.1 The Impact of Resource Development on Individual and Family Well-Being

This was a literature-based study to identify and integrate the conceptual and empirical issues involved in the relationship between rapid development in the Athabasca oil sands region and family and individual adjustment among the indigenous and in-migrating peoples.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Business Development and Tourism, Northern Development Branch; Dr. Lyle E. Larson, Family Research and Consulting Ltd.

STATUS REPORT:

The research began in September 1976, and was completed in February 1977. This study reviews both published and unpublished existing research and conceptual ideas pertaining to the family and social impact studies. The report also proposes a tentative theoretical model and research design for the study of social and personal adjustment in the oil sands region.

SUB-PROJECT TITLE
AND DESCRIPTION: HE 1.2.6 An Exploratory Study of "Deviance" in the Athabasca Oil Sands Area

The purpose of this research was to identify, review, and critically assess the literature on deviance in resource communities; and on this basis, to assess the significance of social deviance in the development of the Athabasca oil sands communities.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Business Development and Tourism, Northern Development Branch; Mr. Harvey L. Johnson

STATUS REPORT:

This report was completed in November 1976. It reviews the phenomena of alcohol and drug abuse, crime and delinquency in the oil sands region, and examines these within the context of existing hard data. A review of literature on resource communities is also included. The study concludes by presenting various recommendations for action and research.

SUB-PROJECT TITLE
AND DESCRIPTION: HE 2.2.1 Research Design for the Study of Social Problems in the Athabasca Oil Sands Region

This project was to design a comprehensive system for assessment and analysis of human problems and social preventive and rehabilitation measures

operating within the AOSERP study area. Specifically, this was to develop a method for studies of the relationship between oil sands development activities and social problems in the region.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Business Development and Tourism, Northern Development Branch; Applied Research Associates Ltd.

STATUS REPORT:

The consultants began their research early in 1976, and the report was submitted in June 1976. An extensive annotated bibliography on Social Problems and the Preventive and Rehabilitation Measures in Resource Communities was also completed as part of this project.

SUB-PROJECT TITLE
AND DESCRIPTION: HE 2.2.2 Community Studies: Fort McMurray, Anzac, Fort MacKay

Relying on field research, the community studies are to begin to clarify the relationship between problems experienced or perceived by the inhabitants of Fort McMurray, Anzac, and Fort MacKay, and the oil sands development activities. Included in this research is to be an analysis of economic, political, and social organization of the communities involved, as well as of the residents' value system. The principal technique of data collection includes "participant observation" and both directed and non-directed interviews. The project represents modified application of the research design developed in HE 2.2.1.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Business Development and Tourism, Northern Development Branch; Applied Research Associates Ltd.

STATUS REPORT:

The work on this project began in September 1976, and the report is due in April 1977.

SUB-PROJECT TITLE
AND DESCRIPTION: HE 2.4 Research Design for the Study of History of the Athabasca Oil Sands Region

To place the present socio-economic processes associated with the oil sands development activities within an appropriate historical context, a research design was commissioned for the study of history of the oil sands region between 1890 and 1967. The design proposes three subjects for historical research: population migration, economic history, and society and government. The traditional historical research methods are to be supplemented by an oral

history program which will fill the "information gap" existing in the primary and secondary sources.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Business Development and Tourism, Northern Development Branch; Mr. James M. Parker.

STATUS REPORT:

The design was completed and the report submitted in November 1976. Included as part of this project are a Bibliography of Published Sources, and a separate Bibliography of Government Publications and Primary Sources.

HYDROGEOLOGY TECHNICAL RESEARCH COMMITTEE RESEARCH ACTIVITIES, 1976-77

The goal of the Hydrogeology Technical Research Committee established during 1976-77 is to ensure that the hydrogeological research necessary to achieve the overall objectives of the Program is undertaken. To achieve this goal the Committee meets with representatives of government, industry, universities and other AOSERP sectors to review the current state of knowledge on groundwater in the Athabasca oil sands area. The committee then recommends funding of the Hydrogeology research programs needed to fill any gaps or deficiencies that have been identified.

During 1976-77, a project was initiated on the shallow groundwater of the Muskeg River basin in response to Aquatic Fauna and Hydrology research needs. The Hydrogeology Technical Research Committee continued to provide guidance to the joint Alberta Research Council - Alberta Energy and Natural Resources groundwater observation well program.

SUB-PROJECT TITLE
AND DESCRIPTION: HG 1.0 Regional Hydrogeology of the Athabasca Oil Sands

The objective of this investigation is to develop a hydrogeological response model for the Athabasca oil sands area. Such a model will provide a reliable framework which is necessary for the solution of technical problems related to oil sands development activities involving groundwater. Although this is not an AOSERP project, AOSERP support service facilities and technical advice are utilized. Funding is by Alberta Energy and Natural Resources.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Energy and Natural Resources, Alberta Research Council. Dr. D. Hackbarth

STATUS REPORT:

Observation wells in the AOSERP study area are being monitored monthly for water levels and annually for water quality. Data publications will be updated. Procedures for digitization, storage, and retrieval of water level hydrographs are nearing completion.

A conceptual model of the groundwater flow system in the Athabasca oil sands area is almost complete. Results should be published by fall 1977 in an Alberta Research Council Bulletin. The project is expected to have achieved its goals and therefore terminate at the end of the 1977-78 fiscal year.

SUB-PROJECT TITLE
AND DESCRIPTION: HG 1.1 Hydrogeological Investigation of the Muskeg River Basin

Over a large area of the Muskeg River Basin, less than 100 feet of glacial drift overlies thick oil sand deposits. It is expected that mining and extraction will begin on leases within the basin in the next few years. The goal of this research is to define more clearly shallow groundwater conditions adjacent to streams. More detailed objectives are to collect and interpret existing hydrogeological data for the basin, to investigate features of the hydrogeology adjacent to the stream system and to develop groundwater system models.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Environment; Dr. F. W. Schwartz, University of Alberta.

STATUS REPORT:

Work on the project began in March 1977. Work is in progress to collect existing geological and hydrogeological data from the area. Isotopic analysis of 20 selected surface water and snow samples has been completed together with the interpretation of the available surface water chemistry. Field work will commence in June 1977.

HYDROLOGY TECHNICAL RESEARCH COMMITTEE
RESEARCH ACTIVITIES, 1976-77

The Hydrology sector has been concerned over the past year with researching and developing techniques for managing the physical, chemical and bacteriological states of the surface water environment. This has involved studies that measured the natural fluctuations in these states (chemical concentrations, bacterial numbers, streamflow) over time. Existing disturbances to natural conditions have been characterized at the source (i.e. chemical analysis of plant effluents and in the mine depressurization water).

Predicting the ultimate fate of surface water effluents is a complex problem. The nature of possible interactions between heavy metals which could be released into the surface water system and soil materials (humic substances) which enter streams through runoff were studied as part of this objective. A project which preliminarily assessed the impact of likely future levels of acid precipitation on the water quality of a set of study area lakes was also supported.

An intensive multidisciplinary study of a typical muskeg watershed was also intitiated, as were streamflow and water quality measurements on the outlet of a predominantly jackpine covered watershed.

A set of 48 watershed maps was produced together with associated drainage areas and stream profiles. These maps will form a uniform basis for presenting AOSERP study results which are watershed oriented.

SUB-PROJECT TITLE
AND DESCRIPTION: HY 1.1 Surface Water Hydrology--Stream Gauging

The objective is to provide adequate streamflow information for an inventory of the hydrologic resources within the oil sands study area. This hydrologic resource information is required for engineering design purposes, as well as to support other environmental projects in the area.

All gauging stations are instrumented with continuous strip chart recorders. Stream water levels are transmitted to the recorders by float arrangements. With this type of instrumentation, water levels are available on a continuous basis for all gauged sites. The conversion of water level information to stream discharge data is accomplished by developing a stage-discharge relationship for each site.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Water Survey of Canada; Mr. M. Spitzer.

STATUS REPORT:

A network of 23 stream locations throughout the study region has been monitored continuously for water flow over the past year through a district office at Fort McMurray. In addition, during the summer, one site was added to characterize the runoff from a small predominantly jack pine watershed, another from a small muskeg watershed, and a third from the eastern slopes of the Birch Mountains.

The levels of Gregoire, Namur, Upper Gardiner and Eaglenest Lakes were also monitored throughout the year.

A report containing all historical raw hydrometric data, some dating back to 1957, and associated statistics, will be available in a later AOSERP publication.

SUB-PROJECT TITLE
AND DESCRIPTION: HY 1.3 Suspended Sediment Data Collection at Some Hydrometric Stations

The development of the oil sands area will alter surface cover which in turn will affect sediment particles reaching streams. Diversion of streams will also alter the stream regime. Changes in sediment composition could affect downstream areas such as the Peace-Athabasca Delta area.

The objective of monitoring suspended sediment at specified gauging station locations is to obtain background information on sediment yield and characteristics prior to, during, and after development in order to assess alterations which can or are occurring so that results can be extrapolated to other areas.

A sampling program on the lower Athabasca River is required to monitor changes in sediments (chemically and physically) to determine if changes can become deleterious to the Peace-Athabasca Delta area and, if so,

how it can be rectified. Also, stations are required upstream of development to determine what is entering the oil sands area.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Water Survey of Canada; Mr. M. Spitzer

STATUS REPORT:

Samples from a network of eight streamflow measurement locations were analyzed for suspended sediments on a regular basis. This project also analyzed suspended sediment samples collected by other studies. A report containing all historical mean monthly concentrations of suspended sediment and associated statistics at sampling sites in the AOSERP area will be available in September 1977.

SUB-PROJECT TITLE
AND DESCRIPTION: HY 2.2 Background Work in Oil Sands Area on Water Chemistry of Lakes Regarding Acidification Potentials

The effects of acid fallout on lakes in the Sudbury, Ontario area have raised concern for lakes in the oil sands area.

Many of the lakes around the Athabasca oil sands region are of higher buffering capacity than those near Sudbury. In far northeastern Alberta and northern Saskatchewan (distances of 200 km or more), there are lakes of very low buffering capacity, as in the Shield area near Sudbury. It is likely that there is a gradient of buffering capacity from lakes in the oil sands area toward the Shield.

The purpose of the project was to devise a scheme to give a general indication of the susceptibility of lakes in the AOSERP study area to acidification as a result of atmospheric fallout from potential and existing oil sands developments. The main objective is to outline a "blueprint" which would be used for planning future studies on hydrology in the AOSERP area. Such a baseline study would allow for the design of studies and prediction of effects (for subsequent verification) of potential oil sands development.

The approach allows for back-calculation of loadings which could be reasonably tolerated by aquatic systems in the AOSERP area, and thus integrates with the work of Aquatic Fauna sub-project AF 2.3.1 reported on page 9.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Fisheries and Marine Service; Dr. R. Hesslien.

STATUS REPORT:

This study investigated the susceptibility of 20 lakes within the AOSERP study boundaries to acidification from acid precipitation. Preliminary conclusions, based upon analogy with those lakes in the Sudbury area which have similar water quality characteristics, are that none of the lakes studied

would become acidified if they were subjected to the same levels of acid loadings as the Sudbury area. However, more comprehensive studies of one or more lakes, including the buffering effects of bottom sediments and natural flushing rate are needed. A preliminary examination of Shield area lakes east and northeast of the study area should also be undertaken to confirm these results.

SUB-PROJECT TITLE
AND DESCRIPTION: HY 2.3 Interaction of Humic Substances with Metallic Elements

Humic substances originating from vegetation, soil, or industrial discharges can combine with toxic heavy metals in water to render them more soluble and thus more available to life forms utilizing the water. The purpose of this project was to predict the effect of oil sands development on the bioavailability of heavy metals in the waters of the Athabasca oil sands area and therefore to produce one measurement of the extent of toxicity problems which may accompany development.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Environmental Management Service, Water Quality Branch; Mr. M. Korchinski

STATUS REPORT:

This study investigated the natural occurrence of heavy metals throughout the surface waters of the AOSERP study area, the chemical form of the metals, and the amounts of metals which could be kept soluble by naturally occurring humic substances in the water.

Results indicate that naturally occurring humic substances in tributaries have a high capacity to interact with and dissolve heavy metals in surface waters and that some significant concentrations of heavy metals occur in the surface waters of tributaries when flow is high. Some geological formations were found to contain significant concentrations of trace metals, while river bottom sediments were void of many trace metals.

The concentrations of trace metals in the Athabasca River system appear to fluctuate considerably. The figures appear related to the natural conditions resulting from the interaction of water-borne humic substances with soils.

SUB-PROJECT TITLE
AND DESCRIPTION: HY 2.4 Pathways of Dispersal of Heavy Metals in the Athabasca River

Oil sands development can potentially alter the transport of sediments, chloride, and heavy metals via the Athabasca River to the Peace-Athabasca Delta. The amount of deposition of salts and sediments in the Delta must be quantified in order to interpret any possible adverse effects.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Environmental Management Service, Inland Waters Directorate; Dr. R. Allan

STATUS REPORT:

This project sampled for the occurrence of heavy metals in bottom sediments along the Athabasca River from Fort McMurray to the Delta and throughout the Delta to the Peace River. The analysis is continuing.

SUB-PROJECT TITLE
AND DESCRIPTION: HY 2.5 Regional and Muskeg Basin Water Quality Sampling

It is necessary to obtain an understanding of natural water quality loadings and processes in the AOSERP study area and establish baseline conditions of surface water quality for current and future studies. This project is to include the identification and association of natural water quality sources with hydrologic and physiographic features in the Muskeg River basin, and a region-wide survey of the dynamic fluctuations in the water quality of AOSERP area tributary streams and the Athabasca River.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Environment; Dr. R. Seidner

STATUS REPORT:

Sixteen stream sites in the Muskeg River basin were surveyed on a regular basis since late July 1975 for streamflow, suspended sediments and a full range of water quality parameters. The study will identify the nature and extent of fluctuations in the physical and chemical states of a muskeg watershed and develop techniques for predicting these states from watershed characteristics.

A regional water quality survey program involving monthly and bi-monthly sampling at 30 hydrometric sites was begun in February 1976 under project HY 2.3. When the short-term needs of that project had been satisfied, the program was taken up by HY 2.5 and expanded. Over 50 water quality parameters are regularly determined at each site. The information collected will define baseline conditions of surface water throughout the region, provide data for the formulation and validation of techniques for predicting water quality under natural and altered conditions in the AOSERP area, and provide background information for concurrent studies. Chemical analyses of collected samples has been done by commercial laboratory - Chemex Labs (Alberta) Ltd.

SUB-PROJECT TITLE
AND DESCRIPTION: HY 2.6 Biochemical Ecology of the Athabasca River, Related to Industrial Use

Bacteria are extremely sensitive to physical and chemical changes that may be imposed by the oil sands development activities, or any other industrial

operations. Any changes (either quantitative or qualitative) in the river's bacterial community will directly reflect changes in water chemistry including silt loading. A study of the bacterial numbers is an important step in understanding the effects of oil sands development on the river's microbial community.

An assessment of both free and silt-associated bacterial populations in the Athabasca River upstream from the oil sands area may provide a baseline from which one can estimate the river's capacity to absorb silt loading, chemicals released from processing operations, and sewage. Assessment of water quality at sites downstream from the oil sands area will provide information regarding the distance necessary for recovery.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Environment; Dr. C. W. Costerton, University of Calgary

STATUS REPORT:

This study involved the selection of a suitable bacteria counting technique (for silty waters) and its application in determining the occurrence of the total number of bacteria along the Athabasca River, at the mouth of the Clearwater River and at the mouth of the Muskeg River throughout the year. Results indicate that in 1976-77, a 20-fold fluctuation in concentrations of bacteria occurred over the year. Bacteria concentrations were the highest in May and in the fall, and lowest in August and in the winter. It was also determined by electron microscope that bacterial colonies were not widely associated with suspended silt particles. There was no significant difference in the numbers of bacteria found above Fort McMurray and below GCOS.

SUB-PROJECT TITLE
AND DESCRIPTION: HY 3.1.1 Evaluation of Organic Constituents in Oil Sands Extraction Plant Wastewaters

This project was designed to characterize and quantify into compound classes the total organic component of wastewaters from an existing oil sands extraction plant, including the seepage from the tailings pond and wastewaters such as bitumen upgrading effluent and coke storage area runoff.

This information can be used to determine the levels of various chemical compounds which could enter the water systems of the oil sands area, and ultimately to determine water quality standards.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Environmental Management Service; Mr. M. Strosher, Kananaskis Environmental Sciences Centre, University of Calgary

STATUS REPORT:

This project continued last year's work on the characterization of the

organic components (types, concentrations) of effluent streams and other sources of surface water quality disturbances associated with oil sands extraction plant wastewaters. A report was issued in March 1977.

LAND USE AND RECLAMATION TECHNICAL RESEARCH COMMITTEE RESEARCH ACTIVITIES, 1976-77

The goal of the Land Use Technical Research Committee is to integrate research data with government development policy for the formulation of a land use plan and to identify the data requirements for regional planning in the oil sands study area.

Six long-term objectives were established for the Land Use Technical Research Committee through which this goal may be met.

1. To obtain knowledge of the factors including the quality, quantity, and use of land resources;

2. To identify the factors affecting industrial siting, such as transportation and infrastructures;

3. To identify the factors affecting town siting, especially with respect to industrial siting and existing population centres;

4. To consider the constraints involving land tenure, mineral tenure, zoning, regional planning, recreation, and native land holdings and uses;

5. To identify and evaluate the area's historical and archaeologic sites; and

6. To identify future population needs as they relate to land use and geographical considerations, subsequent land use, and the rate, sequence and timing of development.

No research was initiated in the 1976-77 fiscal year.

METEOROLOGY AND AIR QUALITY TECHNICAL RESEARCH COMMITTEE RESEARCH ACTIVITIES, 1976-77

The general objectives of the Meteorology and Air Quality Technical Research Committee are to establish baseline climatological and air quality conditions and to develop a better understanding of atmospheric pollution processes relevant to the oil sands area. This will lead to the development of simulation models for the prediction of air quality and air pollution transport and deposition within the area. As a final product, information will be provided that can be used for land-use planning and pollution control strategies.

This report covers the first full year of operation for the Meteorology and Air Quality sector. All data acquisition systems were put on an operational basis in this period and routine monitoring programs started. Contracts for feasibility studies were completed on such topics as low temperature fog, use of satellite photography, weather radar used for precipitation mapping, and others.

Other studies related to an emission inventory for the oil sands area, a climatology for low level air trajectories and a review of chemical transformation processes.

Work was started on atmospheric dispersion modelling with a report being completed on average annual concentrations of sulphur dioxide. A review of relevant dispersion models and user requirements survey was also carried out as part of a larger study to determine the most appropriate type of model for use within the oil sands area.

The second winter field study was held in early February 1977 in which dispersion and SO_2 oxidation measurements were made in the GCOS plume with extensive ground based support.

This combination of field investigations and the apllication of scientific knowledge will permit the quantification of meteorological and air quality characteristics which are unique to the oil sands area.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 1.1, 1.2, 1.3 and 1.4 Data Acquisition - Meteorology

The objective of these sub-projects was to set up and operate systems for collection and processing basic information on the meteorology of the oil sands area which is required for Meteorology and Air Quality research and by other research sectors.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Atmospheric Environment Service; Mr. A. S. Mann

STATUS REPORT:

The principal objective during 1976-77 period was to bring the meteorological data acquisition system up to operational standards. To this end the basic climatological network consisting of eight remote telemetry stations measuring wind, precipitation, temperature and humidity were operational in September 1976. The magnetic tape data processing system to handle the data thus generated was started at the same time.

The meteorological tower recording temperature at five levels and wind at three levels up to 152 meters started continuous operation in October. A bivane measuring turbulence at the top of the tower started recording in November. The minisonde unit started its first balloon flights in January 1977.

Collection of precipitation samples for chemical analysis was carried out during the summer months of 1976 at fourteen sites in the area.

Solar radiation measurements were started at the Mildred Lake base facility in June 1976. Observation of the areal extent of low temperature fog were made in January 1977.

The data from this acquisition system is processed by the AOSERP field operations group of the Atmospheric Environment Service and an up-to-date catalogue kept of all information on file. In addition a monthly summary of selected data is prepared to meet the immediate requirements of researchers.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 1.5.2 Intensive Field Study

The purpose of this study was to examine in detail the atmospheric characteristics of the Athabasca oil sands or AOSERP study area under winter conditions, particularly as they relate to plume behavior and dispersion. The main emphasis in this case was on the chemistry of the plume - its constituents, oxidation rates, and the composition of particulates.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Atmospheric Environment Service;
Drs. F. Fanaki, M. Lusis, R. Mickle

STATUS REPORT:

The weather for this study during 2 - 12 February 1977 was very mild, the mean temperature for the first 15 days of the month being -4.5°C. versus a 30-year normal of -17°C. However, good stable plume conditions were established on several occasions and coherent data sets were collected for analysis both by the plume chemistry and the boundary layer studies.

The plume chemistry group found on several occasions when a good coherent plume was expected, it actually was very spread out and thin under an inversion layer. In one other case with a pronounced west wind aloft, they anticipated considerable dispersion but found the plume to be coherent from less than one kilometer out to 30 km. Due to rising terrain at this distance, it was very close to the ground but yet showed no signs of impinging.

The tethersonde group found several situations which illustrated the separation flow regimes between the river valley and the surrounding plateau.

This study was extensively supported by minisonde observations, plume dispersion measurements by means of photography and radiosonde flights.

A full report on this project will be available in September 1977.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 1.6 The Feasibility of a Weather Radar near Fort McMurray, Alberta

Measurements of precipitation in the vicinity of Fort McMurray are of prime importance for hydrologic studies and land reclamation research. Also, interactions between atmospheric pollutants and precipitation events are significant since deposition of pollutants on the surface often results from the pollutants being "scavenged" by precipitation.

Because of the remote and rugged nature of the area a standard rain gauge network would necessarily be sparse and the results would lack precision. In order to measure precipitation adequately it has been proposed that weather radar be considered, since weather radar can be used to map precipitation patterns with acceptable accuracy over large areas.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Atmospheric Environment Service;
Dr. B. L. Barge, Dr. R. G. Humphries, Ms. S. L. Olson,
Alberta Research Council

STATUS REPORT:

The feasibility of a weather radar to map precipitation in the AOSERP study area near Fort McMurray, Alberta was investigated. Consultations with various groups and agencies associated with AOSERP revealed a need for precise information on precipitation rates, accumulated precipitation amounts and paths of precipitating systems.

It was found that the present raingauge network may sometimes be unable to provide precipitation data with sufficient resolution and accuracy. Careful study of other projects suggests, however, that radar may be able to determine precipitation amounts to within 20 percent over much of the AOSERP study area. The present AOSERP raingauge network may serve as the basis for radar calibration.

Several problems must be carefully investigated before a useful weather radar system can be realized; for example, radar design, melting layer effects, radar location, and most importantly, data management. The use of a weather radar to map precipitation in the AOSERP study area is considered to be economically, technically, and scientifically feasible.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 1.7 Very High Resolution Meteorological Satellite Study of the Oil Sands Weather

The potential advantages of monitoring phenomena on the earth's surface from an orbital vantage point are many. The view of earth from space may be regional or even global in scope; however, with recent high resolution instrumentation, surface features smaller than 80 meters across may be identified.

This study was aimed at examining the feasibility of using satellite photography to monitor the paths of effluent plumes, occurrence of fog, cloud cover and ice cover on lakes and rivers.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Atmospheric Environment Service; Mr. J.M. Mercer and Dr. R.D. Charlton, University of Alberta.

STATUS REPORT:

Imagery from both meteorological and environmental satellite sensor systems was analyzed to determine its applicability in monitoring weather conditions in the Athabasca oil sands. Two sensor systems were the objects of investigation: the multispectral scanner (MSS) aboard the environmental LANDSAT satellites and the Very High Resolution Radiometer (VHRR) aboard the NOAA meteorological satellites.

Weather conditions such as clear and cold, convection cloudiness, and widespread precipitation were studied with the available satellite imagery. The images and known weather conditions were then compared to determine the capability of the satellite-based sensors to identify specific meteorological phenomena. Particulate and thermal conditions of rivers and lakes were also considered.

LANDSAT could resolve meteorological features, such as single cloud elements, but since a given spot is observed only once every nine days, it is quite unsuitable for studying the motion of weather patterns. Slow-changing phenomena such as lake ice, snow cover, and particulate content of water bodies are more effectively defined. NOAA satellites provide the twice-daily coverage needed for monitoring fog, smoke, plumes, and small-scale cloud patterns. Unfortunately, the resolution of the NOAA-VHRR was generally inadequate for identification of small meteorological features associated with industrial development.

Satellites of the near future will have better instruments for covering the meteorology of the oil sands but no combination of their output is expected to provide ideal time and space resolution.

Future studies of this type should find satellite images easily available because of rapidly improving Canadian sources and because of the explanation of image acquisition given in this study.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 2.1 Data Acquisition - Air Quality

The objective of this project was to establish and operate stations for monitoring chemical constituents in air. The information collected will provide a better understanding of the natural air chemistry of the area and may indicate the nature of changes due to urban and industrial development in the area.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Environment, Pollution Control Division; Mr. M. Strosher

STATUS REPORT:

The installation of three major monitoring stations at Birch Mountain, Bitumount and Fort McMurray was completed. These stations routinely measure sulphur dioxide, ozone and particulates. In addition, the Bitumount and Fort McMurray stations measure hydrogen sulphide, carbon monoxide and oxides of nitrogen. Among the metallic elements analyzed in the particulate samples are Pb, Cu, Ma, Cr, Cd, Hg, Zn, Be, V, Ni, Mo and Co.

The data from these stations will be processed on a regular basis and data from other industry operated sites will also be collected, processed and stored.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 2.2 Inventory of Sources and Emissions in the AOSERP Study Area

Before research can proceed in a number of areas, it is necessary to identify the pollutants being emitted into the atmosphere and to determine the quantity and rate of emission of such pollutants. To this end an inventory of sources and emissions is required.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Environment, Pollution Control Division; SNC Tottrup Services Ltd.

STATUS REPORT:

This study is in the advanced stages of completion and identifies all the present atmospheric emissions in the area, both man-made and natural, their sources and rates of emissions. Potential future sources are noted. In the course of this study close contact was maintained with industry and chemical analyses of particulates from mainstack of the one operating oil sandsplant was carried out.

This study includes a comprehensive and efficient computer based retrieval system for the identification and location of emissions in the area.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 2.3.1 Plume Dispersion Measurements from an Oil Sands Extraction Plant

Plume behavior is generally regarded to be unique to geographical areas. In order to establish a comparison to popular theoretical/empirical plume rise models, to normal Gaussian profiles, and to standard deviations as determined from the Pasquill-Gifford stability classes, it was deemed necessary to conduct measurements of SO_2 concentration and turbulence in the plume from an existing oil sands processing plant.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Environment; Dr. D. S. Davison, Mr. C. J. Fortems and Mr. K. L. Grandia, Intera Environmental Consultants Ltd.

STATUS REPORT:

During March 1976, a plume survey program was conducted to determine the diffusion coefficients and turbulence parameters associated with the GCOS effluent plume. Airborne measurements were conducted under various meteorological conditions ranging from stable inversions to neutral stability cases.

Five cases were selected for detailed analysis of plume geometry, mass flux calculations, and turbulence characteristics. Comparisons were made between observed plume structure and the Gaussian-predicted profiles. Lateral and vertical plume spread was derived from each case and compared with the Pasquill-Gifford stability classes. Significant comparisons were made between observed diffusion estimates and the estimates of the standard deviations of the horizontal and vertical wind components.

The analysis of these data continued through 1976. The report will be distributed in June 1977.

SUB-PROJECT TITLE AND DESCRIPTION: ME 3.3 Preliminary Investigation into the Magnitude of Fog Occurrence and Associated Problems in the Oil Sands Area

Industrial and urban growth in other parts of the world have sometimes resulted in increased fog and fog-pollutant problems. This preliminary study was initiated to determine if water fogs, ice fogs, and mixtures of fog and emissions could cause similar problems in the Athabasca oil sands area.

RESPONSIBLE AGENCY AND RESEARCHER: Environment Canada; Mr. B. Croft, Stanley Associates Engineering Ltd.

STATUS REPORT:

The objective of this study was to determine what is known about the magnitude of fog occurrence and the potential impact of fog in the oil sands area of northeastern Alberta. The approach taken was to search the literature relevant to fog formation, characteristics and interaction with pollutants. Information and data on meteorology, topography, and water vapor emissions from the oil sands area were collected. Fog data for Fort McMurray and the oil sands processing plant areas were compared with data from Embarras, Alberta and Fairbanks, Alaska, and calculations were made to estimate the possible extent of fog conditions.

Based on meteorological and historic fog data, Fort McMurray airport experiences four to five days with ice fog and 18 total days with fog per year. There is potential for ice fog to occur in the oil sands area during 10 to 13 days per year covering 320 to 1580 km^2 (two plants) or up to 4000 km^2 (five plants) under severe persistent conditions. Pollutant concentration caused by normal low level emissions could increase two to three times during ice fogs. The potential for pollutant interaction with water fogs is low because plume mixing to the ground during fog occurrence is remote.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 3.4 A Climatology of Low-Level Air Trajectories

This study was designed to provide a climatology of air trajectories in the oil sands area. Such information will contribute to the best design for air and precipitation sampling networks and in the selection of the best locations for sampling soils and lakes to monitor long term trends in pollutant deposition. In addition, it may serve as the basis for a statistical regional dispersion and deposition model.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada; Mr. P.J.Denison, Acres Consulting Services

STATUS REPORT:

The objective of this project was to develop a climatology of air parcel movements (trajectories) over 72-hour periods for parcels moving in to and out from the AOSERP study area. The trajectories were required at 1000 mb (surface), 925 mb (75 m above surface) and 350 mb (1500 m above surface), and for conditions of nil, light, moderate and heavy precipitation. The basic data used to construct the 72-hour trajectories were the four times daily surface and twice daily 850 mb AES weather maps on microfilm for 1968 and 1973-74-75. Seasonal patterns of frequency distribution are consistent from the west for air parcels moving in to the study area and to the east for air parcels moving out from the study area. However, in spring, at the surface, the southeasterly direction is more frequent for air moving in to the study area and the northwesterly direction more frequent for air moving out from the study area.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 3.5.1 A Review of Pollutant Transformation Processes

This project was a review of pollutant transformation processes to determine the present state of knowledge in this field which may be applicable to the oil sands study area.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Atmospheric Environment Service; Drs. O.P. Strausz and J.W. Bottenheim, University of Alberta.

STATUS REPORT:

Chemical transformation processes in polluted atmospheres are described, with particular reference to the northern Alberta oil sands area. The relevant atmospheric chemistry is discussed under four headings: clean air chemistry, oxidant chemistry, SO_2 chemistry, and aerosol chemistry. It is concluded that high ozone concentrations and the formation of PAN-type oxidants would probably take place, especially during the summer when the

ambient concentrations of naturally-occurring reactive hydrocarbons from the wooded surroundings and other evaporated hydrocarbons at the site of the oil sands extraction plants might be sufficient to fuel the oxidant chemistry. Since the major polluting species in the oil sands area is expected to be SO_2, the atmospheric chemistry of SO_2 is reviewed in detail. Homogeneous gas phase reactions via interaction with oxidative processes is indicated to be a probable prime transformation route for the conversion of SO_2 to sulphate during the summer, while aqueous phase reactions will be of importance all year round. Purely heterogeneous reaction routes are expected to be of minor importance. In reviewing the published literature, emphasis was given to recent studies, up to December 1976, resulting in a list of 428 references.

Those studies having direct relevance to the climatic and geographic conditions of northern Alberta are described in a separate chapter. In this regard, the effects of low winter temperatures and the large difference in the amount and spectral distribution of available sunlight between summer and winter are indicated and compared with results from a few other unrelated studies which can be extrapolated to northern Alberta, in order to make a prognosis on how these factors might influence the chemical evolution of polluted atmospheres.

Atmospheric chemical transformation processes for which mechanistic or experimental data are lacking are identified and some research projects which would lead to a better understanding and prediction of the chemistry of polluted air are proposed, with special emphasis on the particular problems which may arise in the vicinity of the oil sands extraction plants.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 3.5.2 Pollutant Transformation Processes

This project consisted of a series of field measurements to determine SO_2 oxidation rates in the GCOS plume in winter.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Atmospheric Environment Service; Drs. M. Lusis and L. Barrie

STATUS REPORT:

Measurements were made during the February 1977 winter field study of plume profiles and SO_2 oxidation rates within the GCOS plume. Filter packs were used for the collection of total particulate sulphur, sulphuric acid and metals which are capable of acting as catalysts for SO_2 oxidation.

Preliminary results indicate that for distances to about 30 km, the percentage of sulphur in the form of particulates was found to be low - always less than 5% and typically about 1.5%. The analyses completed so far indicate oxidation rates of SO_2 to sulphate to be very small, probably less than 1% per hour.

Work is continuing on the analysis of these data and a full report will be available in September 1977.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 3.8.1 Plume Rise and Diffusion Studies

In order to evaluate plume mixing and dispersion rates by means of atmospheric models, it is necessary to know the turbulence characteristics associated with various stability regimes. This project aims to estimate, by means of bivane turbulence measurements at the top of a 150 meter tower, the atmospheric dispersion coefficients relevant to pollutant plumes from the GCOS plant under weather conditions typical to the area.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Atmospheric Environment Service; Dr. H. E. Turner

STATUS REPORT:

Bivane data were collected for several periods during the winter and spring of 1977. They are in the process of being analyzed and the results should provide preliminary estimates of diffusion characteristics and indicate the direction of further studies.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 3.8.2 Literature Survey and Synthesis of Turbulence Measurements

The object of this project is to review the work done in other parts of the world in deriving turbulence measurements through statistical theory and to determine to what extent it can be applied to plume mixing and dispersion rates in the oil sands area.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Atmospheric Environment Service

STATUS REPORT:

The specifications were prepared for a literature survey and synthesis of turbulence data but further action was not taken pending the results of a study of requirements for an atmospheric dispersion model.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 4.1 Application of the Climatological Dispersion Model

This project involves the analysis of existing seasonal and annual meteorological data in order to estimate pollution impact areas on a climatological time scale.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Atmospheric Environment Service; Dr. J. L. Walmsley, Mr. D. Bagg

STATUS REPORT:

The Climatological Dispersion Model and the input data required for calculation of annual averaged values of sulphur dioxide concentrations at ground level are described. The most important meteorological input to the model is the long-term joint frequency distribution of winds in the vicinity of the sources of atmospheric pollution. These data are computed with the help of statistics of wind correlation between Fort McMurray and Mildred Lake.

Numerous experiments were performed with and without parameterized pollutant removal processes. The effect of incorporating terrain in the model is examined. Experiments comparing concentrations due to existing sources with those due to existing and future sources are performed. Results are also compared with observational data from pollution monitors and snow pack sampling. Estimates are made of sulphur loading due to dry deposition.

SUB-PROJECT TITLE
AND DESCRIPTION: ME 4.2.1 Atmospheric Dispersion and Transport Model Development

The object of this study is to critically survey existing models and, if necessary, adapt them or generate new models that can simulate the transport, dispersion, transformation, and eventual deposition of air pollutants on the local and regional scales as required for predicting major (or preferred) impact areas for other sectors studying air pollutant effects, and ultimately, land use planning and pollution control strategy.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Atmospheric Environment Service; Dr. J. Padro

STATUS REPORT:

A preliminary review of atmospheric dispersion models has been completed and a survey of user requirements carried out. The final report with recommendations on appropriate models for oil sands area studies is in preparation.

TERRESTRIAL FAUNA TECHNICAL RESEARCH COMMITTEE
RESEARCH ACTIVITIES, 1976-77

The goals of the Terrestrial Fauna research sector are to provide the scientific and technical data base concerning animals and animal habitats most important to man, keeping in mind the possible development of, and environmental damage to the AOSERP study area. This will provide some of the information necessary for the establishment of an acceptable oil sands area development plan. It is also the goal of this sector to provide the technical knowledge required in order to predict and minimize the social and environmental impact of wildlife habitat loss caused by extensive development of the Alberta oil sands.

The methodology by which these goals are to be met may be briefly outlined as follows:

1. To provide baseline information on wildlife populations for research programs and land use planning in order to minimize the negative impacts of oil sands development.
2. To collect and provide the scientific and technical data base necessary to determine the presence or absence of terrestrial fauna within the oil sands intensive study area and on those specific areas adjacent to the intensive study area.
3. To establish methods for minimizing or ameliorating the negative impacts of oil sands development on wildlife populations and habitat and provide information necessary for land use planning and development.
4. To collect data related to specific problems associated with specific species within the oil sands study area with the aim to reduce or minimize environmental damage expected during the development of the Athabasca oil sands.
5. To assemble and analyze all wildlife information for land use planning and future resource management.
6. To utilize information obtained under the AOSERP for intensive management purposes.

The following areas were investigated during the 1976-77 fiscal year.

SUB-PROJECT TITLE
AND DESCRIPTION: TF 1.1 Large Mammal Ecology - Ungulate Inventory

The requirement to study moose, caribou, and wolf populations in the oil sands area is based on three predictions: (1) changes in the landscape and additional human activity associated with the industrial development will have significant effects on ungulates and large carnivores of the region; (2) these forms of wildlife constitute renewable resources having economic, social, recreational, aesthetic and scientific values to the people of the region; and (3) preservation and management of these resources will require additional information on the natural control and regulation of populations, the interactions with man as a hunter or trapper, and the effects of disturbances from oil sands development on wildlife populations.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Recreation, Parks and Wildlife, Fish and Wildlife Division; Dr. L. B. Keith, University of Wisconsin

STATUS REPORT:

Research was initiated midway through the 1975-76 fiscal year in three geographic areas: AOSERP-moose, caribou and wolf study, Rochester-moose study, and Swan Hills-wolf study. The AOSERP study area around Fort MacKay includes the oil sands leases most likely to be developed as well as areas that will remain relatively unchanged. The moose populations in the study area will undergo a continuum of disturbance ranging from an occasional cutline to complete disruption of large tracts of land.

Daily, seasonal and yearly moose activities were determined by capturing, tagging and/or radio collaring animals and relocating by use of aircraft. In addition to the location of the animal, information on activity, reproduction, mortality, associates and vegetation-terrain was recorded.

The Rochester study area (near Edmonton) is unique in that moose population dynamics can be studied in absence of hunting or wolf predation while factors such as vegetation, soils, climate and human and industrial activities are similar to the AOSERP study area.

Woodland caribou research in the Birch Mountains is initially concerned with obtaining preliminary information on group size fluctuations, and weekly and seasonal movement patterns to facilitate estimates of distribution and density. Habitat use, reproduction, mortality and time-specific home ranges were also documented.

Concurrently, two wolf populations, one in the Swan Hills and the other in the AOSERP study area, are being studied to determine wolf-moose-human interactions and wolf populations dynamics.

The Swan Hills area was selected for inital investigation because the Alberta Fish and Wildlife Division has conducted a radiotelemetry study of moose in the region since 1971. This study provided the moose distribution and population information necessary to examine moose-wolf interactions.

The wolf research in the AOSERP area was conducted in conjunction with the moose and caribou studies because information on the major prey species is an essential component.

An interim report has been received which covers average home range size, seasonal differences in movements, usage of major cover types, cow-calf ratios,

twinning rates, age distribution and regional densities, and discusses the importance and possible implication of each.

SUB-PROJECT TITLE
AND DESCRIPTION: TF 1.2 Relationships Between Habitat Strata, Forages, and Carrying Capacity of Moose Range

Moose are the primary ungulate species in the oil sands area. To encourage this wildlife resource to utilize the area after industrial development, detailed information about preferences, quantity and quality of moose habitat is required.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Recreation, Parks and Wildlife, Fish and Wildlife Division; Mr. R. Nowlin

STATUS REPORT:

This sub-project has been completed and the final report is being reviewed. The following is abstracted from this report.

Habitat utilization results for specific categories of use indicate that aspen, aspen-white spruce, and aspen-jack pine are first, second and third, respectively, in importance for both feeding and bedding. However, the non-feeding-bedding category revealed that aspen and aspen-jack pine were equally most important, and were followed by jack pine.

Clearly, the most heavily utilized browse species was saskatoon. Beaked willow was the second most important. All other species were used in minor amounts.

From the discussion, it appears that destruction or alteration of aspen, aspen-white spruce, and aspen-jack pine habitats could have significant impact on the moose population. Habitats heavily utilized during the fall season for feeding, bedding, and non-feeding-bedding would be lost.

SUB-PROJECT TITLE
AND DESCRIPTION: TF 1.3 The Effect of Oil Sands Development on the Ecology of Black Bears

Black bears are a major wildlife component of the AOSERP study area. This animal is not only vulnerable to habitat destruction brought about by oil sands development, but can also cause severe human-bear interaction problems associated with development.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Recreation, Parks and Wildlife, Fish and Wildlife Division; Mr. B. Pelchat

STATUS REPORT:

The black bear ecology project is being conducted at Cold Lake, Alberta where research has been conducted by the Fish and Wildlife Division since 1968. AOSERP recognized the strong data base available and supported the ongoing project to meet its specific needs. A sample of bears were captured and fitted with radio collars to determine responses of individual animals to habitat alterations and refuse disposal.

Using the data collected in Cold Lake, a report has been prepared estimating the production for the AOSERP study area. Expected densities for each of five forest cover classes were calculated, and black bear populations by township and total population estimated.

SUB-PROJECT TITLE
AND DESCRIPTION: TF 2.1 Inventory - Avifauna: Passerines, Upland Birds and Waterfowl

The objective of the avifuana research project is to assess the potential impacts of oil sands development on the populations of indigenous and migratory birds in the Athabasca oil sands area. In order to predict the impacts, it is necessary to obtain baseline information on the species and numbers of birds utilizing the area. Other than localized bird studies sponsored by a development company, and waterfowl studies in the Peace-Athabasca Delta, data on the avifuna resource of the oil sands area are limited.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Environmental Management Service, Canadian Wildlife Service; Mr. E. Hennan

STATUS REPORT:

The avifuana project commenced in 1975 and is to be concluded during the 1977-78 fiscal year. The project is divided into three major sections: (1) upland game birds; (2) waterfowl; and (3) terrestrial birds.

The scope of the upland game studies was limited to brief winter surveys of bird populations in four major habitat types: jack pine, aspen, aspen-white spruce and black spruce.

The 1976 waterfowl survey expanded the data regarding populations utilizing a variety of wetland habitats in the AOSERP study area. The project was designed to provide a more definite measure of waterfowl production than had previously been obtained and to assess more accurately, the habitat factors governing selection of wetlands by various waterfowl species. A total of 64 waterbodies were surveyed on 10 different occasions.

SUB-PROJECT TITLE
AND DESCRIPTION: TF 2.2 The Effects of Oil Sands Development on Rare and Sensitive Bird Species

Baseline studies are required to determine the effects of industrial development on endangered, potentially threatened and sensitive avifauna species in the Athabasca oil sands region. Initial assessments will include the AOSERP study area and areas immediately adjacent which may be affected. These studies relate to declining species as well as species which may be locally endangered because of sensitivity to human interference. In this context, the definition will include raptorial birds (peregrine falcon, golden eagle, bald eagle, osprey), colonial birds (pelican, terns, gulls) and other sensitive species (cranes, loons).

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Environmental Management Service, Canadian Wildlife Service; Mr. R. Beaver and Mr. R. Fyfe

STATUS REPORT:

A. White Pelican:

The activities in the 1976-77 fiscal year consisted of a continuation of the baseline studies initiated in the summer of 1975. These baseline studies are an investigation into the breeding behavior, reproductive chronology, reproductive success and distribution of the white pelican in the AOSERP study area.

The interim report for 1976-77 on breeding behavior and distribution stated that white pelican nesting was found at only one location in the Namur Lake area and on an island in an unnamed lake in the Snipe Creek drainage. Sixty-eight young were raised from a total of 140 nests.

B. Raptors, Colonial Nesters (excluding white pelicans), Other Sensitive Species

Beginning in May, the second year of the inventory proceeded. However, the area included was reduced in extent from the 1975 surveys due to logistical constraints. Only a portion of the adjacent areas with recreational potential was included in the 1976 surveys. Both the 1975 and 1976 surveys have been of value in identifying breeding territories and determining species composition and relative abundance, though the late start of the surveys in both years did not allow for the collection of sufficient data to assess the changing status of specific nest sites during the breeding season.

The interim report on rare, potentially endangered and sensitive birds in the oil sands and adjacent areas of northeastern Alberta gives the results of the survey on raptorial birds, colonial birds, terns, gulls, and other sensitive species.

SUB-PROJECT TITLE
AND DESCRIPTION: TF 3.0 Studies of Semi-Aquatic Mammals in the Alberta Oil Sands Area

Aquatic furbearing mammals are a renewable natural resource of

considerable economic importance in the AOSERP study area. Industrial development of the oil sands resource will alter wetland habitats with potential detrimental effects on associated wildlife. This study will initially identify baseline states in order to develop methods of minimizing any adverse environmental effects of the industrial development.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Recreation, Parks and Wildlife, Fish and Wildlife Division; Dr. F. F. Gilbert, University of Guelph

STATUS REPORT:

The 1976-77 activities of the semi-aquatic mammals study were initiated in September 1976. Two campsite areas for field studies were selected, one at Kearl Lake and one south of the Birch Mountains. The interim report on semi-aquatic mammal studies has been received and gives details of activities and results. Trapper cooperation was initiated for the purpose of carcass collection. Beaver surveys and an active muskrat house count were conducted for the Muskeg River drainage and the Syncrude lease area.

The otter track count could not proceed due to unfavorable snow conditions, nor could the habitat classification be initiated due to the unavailability of appropriate aerial photography for the area.

SUB-PROJECT TITLE
AND DESCRIPTION: TF 5.1 The Herpetofauna of the Alberta Oil Sands Region

Amphibians and reptiles are a component of the terrestrial fauna group present in the AOSERP study area. As the Terrestrial Fauna Technical Research Committee addresses itself to the study of all wildlife species in light of potential adverse effects brought about by oil sands developments, the amphibian and reptile group has been included to complete the total ecological approach. This project will determine the baseline state of the populations and habitat types of the species present.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Recreation, Parks and Wildlife, Fish and Wildlife Division; Dr. W. Roberts

STATUS REPORT:

Three species of amphibians were found within the AOSERP study area - wood frogs (the most common in the area), boreal chorus frogs and Canadian toads. Individuals were described as to developmental stages or size classes, body measurements were taken, and site description recorded. Other amphibian species and reptiles appeared to be either absent or only locally abundant. The project will be completed in 1977-78.

SUB-PROJECT TITLE
AND DESCRIPTION: TF 6.1 Recreational Use of Wildlife and Fisheries in the Alberta Oil Sands Region

The current levels of consumptive and non-consumptive use of the wildlife and fisheries resource are unknown for the AOSERP study area. As oil sands development disturbance in the area increases, with concomitant dispersal of natural fish and wildlife resources, it is possible that the loss of recreational opportunity to residents of the area may require rationing for future use.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Recreation, Parks and Wildlife, Fish and Wildlife Division; Dr. Wm. Phillips, University of Alberta

STATUS REPORT:

This study has been concluded. Results are given in detail on non-consumptive recreational fish and wildlife related activities, number of recreation days spent by Alberta and study area residents involving fish and/or wildlife, numbers of fish and wildlife harvested per year, and total extramarket benefits to Alberta and to the Athabasca oil sands area's residents.

SUB-PROJECT TITLE
AND DESCRIPTION: TF 6.2 Trapper Demography, Motivation and Trapping Patterns in the Oil Sands Area

The fur industry was largely responsible for the initial exploration, habitation and development of northeastern Alberta. Although the importance of the fur industry has declined, the industry still contributes important economic resources to the local communities. The establishment of a large new wage economy will have numerous impacts, one of which will be on the fur industry. The project is designed to measure that impact, predict future impacts, and recommend alternative management strategies.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Recreation, Parks and Wildlife, Fish and Wildlife Division; Mr. M. Fox, University of Calgary

STATUS REPORT:

A large sample of trappers from the Anzac, Fort McMurray and Fort MacKay areas was interviewed to obtain socio-economic information on the trapping industry. The project is to be completed by December 1977, and the report on results will follow.

SUB-PROJECT TITLE
AND DESCRIPTION: TF 6.3 Integration of Remotely Sensed and Field Acquired Information

The project is to assess the usefulness of remote sensing techniques for environmental management in the Athabasca oil sands region. The characteristics and advantages of various types of remotely sensed imagery are examined to develop an optimum procedure for analyzing the imagery in conjunction with information generated by ground studies.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Recreation, Parks and Wildlife, Fish and Wildlife Division; Mr. S. Aronoff, University of Calgary

STATUS REPORT:

Thermal imagery and color infrared photography were acquired for the sub-project study area. During the summer of 1976, 118 ground plots were surveyed. The project is to be completed in September 1977, and the report will follow.

VEGETATION TECHNICAL RESEARCH COMMITTEE
RESEARCH ACTIVITIES, 1976-77

The Vegetation Research Sector program for the 1976-77 fiscal year has been a continuation under the direction of the Vegetation Technical Research Committee of the efforts initiated during the 1975-76 fiscal year. The research was directed to the general questions of:

1. the effects that oil sands development is likely to have on the existing vegetation and ways and means of avoiding or overcoming any negative impacts, and

2. the use of vegetation in the reclamation of lands disturbed as a consequence of oil sands development.

Progress reports on each of the vegetation sub-projects funded during the fiscal year follow.

SUB-PROJECT TITLE
AND DESCRIPTION: VE 2.1 Soils Inventory of the Oil Sands Area

This project will provide baseline premining inventory data on soils and landforms for the AOSERP study area. This information will be used to aid in the selection or expansion of research sites, to permit an estimate of the value of present resources, to provide background data for future impact studies and to provide a means of monitoring resource changes caused by disturbance.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Energy and Natural Resources; Mr. J. D. Lindsay, Alberta Research Council

STATUS REPORT:

Work began on this survey in late spring 1976, and the biophysical land classification is patterned after that of Lacate (Guidelines for Biophysical Land Classification. 1969. Dept. of Fisheries and Forestry, Can. For. Serv. Publ. No. 1264). The aerial photographs being employed are 1974 black-and-white Panchromatic taken at a scale of 1:50,000. Field mapping is being compiled on 1:50,000 topographic maps with reduction to 1:250,000 planned for final publication. The area mapped and classified to date includes about 420,000 hectares in a block defined by Ranges 4 to 12 and Townships 87 to 92, West of the Fourth Meridian, inclusive. This area lies within the high priority section of the AOSERP study area, as identified by the Vegetation Technical Research sector.

SUB-PROJECT TITLE
AND DESCRIPTION: VE 2.3 Vegetation Inventory of the AOSERP Study Area

This project will provide baseline inventory data on vegetation and habitats in the AOSERP study area. The information obtained will aid in the future selection or expansion of research sites, permit an estimate of the value of present resources, provide background data for future impact studies, and provide a means of monitoring resource changes caused by disturbance.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Energy and Natural Resources; Northwest Surveys (Yukon) Ltd.

STATUS REPORT:

A small portion of the study area was flown and photographed when it was found impossible to have the entire area photographed in this fiscal year. The area photographed yields a good cross-section of the area from Namur Lake to McClelland Lake, with a scale of 1:15,000. Color prints and false-color infrared transparencies were produced.

SUB-PROJECT TITLE
AND DESCRIPTION: VE 3 Effects of SO_2 on Vegetation

Sulphur dioxide in sufficient concentrations is toxic to vegetation and causes degradation of soils and water. There is a likelihood that with extensive development, significant amounts will ultimately be discharged into the atmosphere associated with the oil sands region. Other pollutants will be released as well, including nitrogen oxides, ozone, and the trace metals, vanadium and nickel. There is potential for considerable harm to the environment resulting from these releases. Diagnostic, sensitivity, and tolerance information as related to vegetation and soils is presently inadequate to detect and appraise impact of these pollutants and to prescribe treatment should such needs develop.

The project is divided into three sub-projects, listed below.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Environmental Management Service, Canadian Forestry Service; Dr. S. S. Malhotra

STATUS REPORT: VE 3.1 Symptomology of SO_2 Injury to Vegetation

An herbarium collection of both vascular and cryptogramic species has been made in the vicinity of oil sands operations. This, as well as photographs of air pollution injury, is the initial step in defining the impact of air pollutants on vegetation. A fumigation chamber has been designed and constructed to aid in the quantification and definition of these systems by allowing control of environmental conditions and SO_2 exposure rates. Preliminary symptomology trial runs are currently underway using the Siemen's gas exchange microchamber.

VE 3.3 Physiology and Mechanisms of SO_2 Injury to Vegetation

Substantial experimentation has been carried out with pine needles exposed to SO_2 in aqueous solution. Results show effects on total chlorophyll content, chlorophyllase activity, ultrastructural studies and the effects of SO_2 on tissue glycolipids and permeability properties.

VE 3.4 Ecological Benchmarking and Biomonitoring for Detection of SO_2 Effects on Vegetation and Soils

Permanent field plots were established in 12 areas, based on tree cover species, prevailing wind direction, topography and distance from the existing oil sands plant. Stand order was determined, and some biomonitoring through tissue sample analysis has been completed. Lichen transplant plots were also established as a biomonitoring tool.

SUB-PROJECT TITLE
AND DESCRIPTION: VE 3.5 Air Pollution in the Athabasca Oil Sands - Effects on Vegetation, 1976 - Reconnaissance Survey/Research Design and Development

The research undertaken in the Whitecourt area of Alberta was designed

to determine the impact of sulphur gas emissions on vegetation. It was broken into five major subject areas: (1) ecological quantification; (2) meteorological/ambient sulphur gas emissions; (3) gas-exchange physiology/controlled fumigations; (4) water relations; and (5) sulphur isotopes.

This project was designed to determine the extent of transferability of the research design and findings and technological developments in the Whitecourt area to the Athabasca oil sands/AOSERP area.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Energy and Natural Resources; Dr. A. H. Legge, Kananaskis Environmental Sciences Centre, University of Calgary

STATUS REPORT:

A copy of the Whitecourt Study Group report, incorporating the AOSERP analyses, will constitute the final report to AOSERP. This final report is currently under review by funding organizations.

SUB-PROJECT TITLE
AND DESCRIPTION: VE 4.1 Soils Research Related to Revegetation of the Oil Sands Area

This project will characterize in detail the soil materials to be reclaimed following oil sands development. It will also develop ways of improving soil factors affecting the eventual production of a stable soil-plant system for use in developing sound management programs and to ensure successful revegetation of the disturbed area.

The soil sulphur component will determine the mechanisms and rate of SO_2 uptake by soil, will find the effect this has on soil pH, available sulphur and biological activity, and will determine the extent of SO_2 damage to soils and possible counter-measures against this damage.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Energy and Natural Resources; Dr. F. D. Cook, University of Alberta

STATUS REPORT:

In the soil physics portion, 11 field sites were instrumented (eight on sand, two on the GCOS dike, and one on till), to monitor ground temperatures, soil mosture tensions, moisture content, and the position of the water table. The effect of additions of till and peat to tailings sand on its moisture characteristics was investigated in the laboratory. Lysimeters were used to provide a means of studying chemical and physical characteristics and process of soils in greater detail, e.g., information on the biogeochemical cycling of nutrient elements.

In studying the impact of SO_2 on soils, a number of canisters containing

specified soil materials were set out in the AOSERP study area and changes in soil acidity and sulphur contents are being measured. Accompanying data have been obtained in regard to acidity and sulphur concentrations in rainfall, throughfall and stemflow.

SUB-PROJECT TITLE
AND DESCRIPTION: VE 5.2 Characterization and Utilization of Peat in the Oil Sands Area

Peat is the only organic material naturally available for rebuilding soil fertility after mining. This project will identify the baseline state of peat at a limited number of in situ locations and industry storage piles, in terms of classification and physical and chemical properties. It will identify the nature and extent of interactions between the environment and stored peat. This information will permit prediction of changes in peat characteristics with handling and storage, and if peat quality is found to deteriorate during storage, the research will investigate alternate methods of storage and handling.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Energy and Natural Resources; Mr. J. D. Lindsay, Alberta Research Council

STATUS REPORT:

A literature review is being conducted within this project. Field study sites have been selected and classified, and peat samples have been analyzed in the laboratory for cation exchange capacity, exchangeable cations, base saturation, pH, total nitrogen, total carbon, phosphorus, and ash content. The physical characteristics under investigation include bulk density, air capacity, water capacity, fibre content, hydraulic conductivity, soil permeability, oxygen consumption, and the determination of bacterial and fungal populations. The effects of the freeze-thaw cycle, drying, and priming by adding carbon on various characteristics were also studied.

SUB-PROJECT TITLE
AND DESCRIPTION: VE 6.1 Long Term Prediction of Vegetation Performance for Dike Management

The purpose of this project is to develop and evaluate potential management strategies for long-term maintenance of vegetative cover on the steep-sided dikes created by surface mining operations in the Athabasca oil sands. The changing environmental conditions and responses by vegetation to those conditions will be monitored, initially over a two-year period.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Energy and Natural Resources; Dr. L. C. Bliss, University of Alberta

STATUS REPORT:

Work on this project was begun by the establishment of a study into plant physiology of existing native vegetation in an undisturbed mature forest microenvironment on a sandy site near the Richardson Fire Tower. The vegetation on the study site has been described in detail. The site has been instrumented for intensive monitoring of microclimatic factors, and intensive 24-hour data collection runs have been made. Soil physics, plant physiology, canopy geometry, light quality, non-vascular plants, mycorrhizae, and energy inputs are being studied and related. Some specialized growth chambers have been constructed to facilitate the measurements of plant response to climatic changes. Computer modelling of results is underway.

SUB-PROJECT TITLE
AND DESCRIPTION: VE 7.1 Reclamation for Afforestation by Suitable Native and Introduced Tree and Shrub Species

Testing of suitable native and introduced tree and shrub species for oil sands reclamation is necessary in order to determine possible timber production, watershed protection, and wildlife habitat improvement. The experiments being conducted within this project will find the best-suited trees and shrubs for oil sands reclamation work.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Energy and Natural Resources, Alberta Forest Service; Mr. J. E. Selner

STATUS REPORT:

The project study area is located on the GCOS lease, and test plots were situated on the dike and on overburden material. Testing for reclamation suitability was done on 24 species of trees and shrubs and 23 clones of poplars. The variables studied included: amendment of soil with peat, the effect of planting methods on effectiveness and survival of the seedling, direct seeding vs. planting, size and depth of planting poplar cuttings, and the success of fall vs. spring planting of container seedlings.

SUB-PROJECT TITLE
AND DESCRIPTION: VE 7.1.1 Continued monitoring of the Harmful Small Mammal Problem in the Alberta Oil Sands Reclamation and Revegetation Program

The success of the tree planting program on the GCOS tailings pond dike has varied greatly. A large number of newly-planted trees, particularly the deciduous species, have been found to be girdled by a population of small mammals that have inhabited the dense grass planted as a cover crop for the trees.

Associated with VE 7.1, this project was designed to assess small mammal

populations on representative sectors of the GCOS dike and to develop an effective method of rodent control.

RESPONSIBLE AGENCY
AND RESEARCHER: Environment Canada, Environmental Management Service, Canadian Wildlife Service; Dr. A. Radvanyi

STATUS REPORT:

In 1975, five study sites were established on sectors of the GCOS dike. In 1976, an additional two study sites were established on overburden piles. All study grids were live trapped for 10 consecutive days per trapping period in early and late summer. Poisoned bait feed stations were also established as a method of rodent control.

Small mammal populations by species, age class, and territory were calculated from the resulting data.

SUB-PROJECT TITLE
AND DESCRIPTION: VE 7.2 Controlled Environmental Test of Species Suitable for Revegetation

VE 7.3 Field Trials to Test Plant Communities

VE 7.4 Technology of Seed Production and Handling

These three projects were designed to (1) provide preliminary information about the adaptability of selected ecotypes and landraces to certain environmental conditions and soil types; (2) provide the information necessary to recommend plant communities for revegetation of disturbed areas; and (3) provide the information for seed production and handling of native grasses, legumes and shrubs.

RESPONSIBLE AGENCY
AND RESEARCHER: Alberta Energy and Natural Resources; Vaartnou & Sons Enterprises Ltd.

STATUS REPORT:

Greenhouse tests were conducted using a variety of native and naturalized plant species on tailings sand, tar sands, and samples of other northern Alberta soil types. Native and naturalized plant species of grasses, legumes and shrubs were established in field test plots at the Woodbend Research Station in Devon, the Waskateneau Nursery Plots, and the Alberta Environmental Research Station in Vegreville.

In the oil sands area, experimental sites were established at the AOSERP Mildred Lake research facility, the Thickwood Hills, and on the GCOS tailings pond dike, a waste dump, and an overburden pile.

ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

MINISTERS

Hon. David J. Russell
Minister of the Environment
Government of Alberta

Hon. Romeo LeBlanc
Minister of Fisheries and the Environment
Government of Canada

PROGRAM MANAGEMENT AND COMMITTEE MEMBERS

STEERING COMMITTEE

W. Solodzuk, P.Eng.
Chairman, Steering Committee
Deputy Minister, Alberta Environment

R. E. Bailey, P.Eng.
Alternate for Alberta
Director, Special Environmental Projects
Alberta Environment

J. S. Tener, Ph.D.
Member, Steering Committee
Assistant Deputy Minister
Environmental Management Service
Environment Canada

A. H. Macpherson, Ph.D.
Alternate for Canada
Director-General, Western and Northern Region
Environmental Management Service
Environment Canada

ADVISORY COMMITTEE ON PROGRAM COORDINATION

Milt G. Pahl
Chairman, Advisory Committee
Director, AOSERP

W. Cary
Chairman, Oil Sands Environmental Study Group
Environmental Coordinator
Great Canadian Oil Sands Limited

Ralph Nursall, Ph.D.
Alberta universities representative
Department of Zoology
University of Alberta

John S. Loch
Chairman, Aquatic Fauna TRC
Section Leader, Environmental Impact
Freshwater Institute
Environment Canada

Paul W. Conway
Chairman, Human Environment TRC
Director of Program Development
Northern Development Branch
Alberta Business Development and Tourism

Maurice A. Carrigy, P.Geol.
Chairman, Hydrogeology TRC
Vice-Chairman, Alberta Oil Sands Technology and Research Authority

Ronald K. Deeprose, P.Eng.
Chairman, Hydrology TRC
Director, Technical Services Division
Alberta Environment

Henry W. Thiessen, P.Ag.
Chairman, Land Use and Reclamation TRC
Assistant Deputy Minister,
Environmental Coordination Services
Alberta Environment

Fred W. Burbidge
Chairman, Meteorology and Air Quality TRC
Superintendent, Scientific Services
Atmospheric Environment Service
Environment Canada

Fred W. McDougall
Chairman, Vegetation TRC
Assistant Deputy Minister, Alberta Forest Service
Alberta Energy and Natural Resources

David J. Neave
Chairman, Terrestrial Fauna TRC
Chief Biologist, Fish and Wildlife Division
Alberta Recreation, Parks and Wildlife

PROGRAM MANAGEMENT STAFF

Milt G. Pahl
Director

Mel F. Falk
Acting Assistant Director, Research

J. Michael Harvey, Ph.D.
Acting Assistant Director, Research

Ronald R. Wallace, Ph.D.
Research Manager, Aquatic Fauna

Barbara M. Kasinska-Banas
Research Manager, Human Environment

C. Robert Froelich, P.Eng.
Research Manager, Hydrology

Avard S. Mann
Research Manager, Meteorology and Air Quality

Ronald G. Weatherill
Research Manager, Terrestrial Fauna

Robert A. Hursey, Ph.D.
Research Manager, Vegetation

D. B. (Dirk) Hadler
Field Manager - Fort McMurray

P. Stuart Grant
Program Coordinator, Support Services

Adeline A. Andronyk
Receptionist

Carol L. Boyle
Stenographer - Fort McMurray

Laura V. Brouilette
Stenographer

Sandra J. Brown
Technical Assistant

Beverly A. Calhoun
Technical Assistant

Grace Lee
Cartographer

Linda M. MacKay
Publications Assistant

Martin Rehn
Financial Officer

LIST OF AOSERP RESEARCH REPORTS

1		AOSERP First Annual Report, 1975
2	AF 4.1.1	Walleye and Goldeye Fisheries Investigations in the Peace-Athabasca Delta--1975
3	HE 1.1.1	Structure of a Traditional Baseline Data System
4	VE 2.2	Preliminary Vegetation Survey of the AOSERP Study Area
5	HY 3.1	Evaluation of Wastewaters from an Oil Sands Extraction Plant
6		Housing for the North--Stackwall System Construction Report
7	AF 3.1.1	Synopsis of the Physical and Biological Limnology and Fishery Programs within the Alberta Oil Sands Area
8	AF 1.2.1	Impact of Saline Waters upon Freshwater Biota (A Literature Review and Bibliography)
9	ME 3.3	Preliminary Investigation into the Magnitude of Fog Occurrence and Associated Problems in the Oil Sands Area
10	HE 2.1	Development of a Research Design Related to Archaeological Studies in the Athabasca Oil Sands Area (at print)
11	AF 2.2.1	Life Cycles of Some Common Aquatic Insects of the Athabasca River, Alberta
12	ME 1.7	Very High Resolution Meteorological Satellite Study of Oil Sands Weather, "A Feasibility Study"
13	ME 2.3.1	Plume Dispersion Measurements from an Oil Sands Extraction Plant
14	HE 2.4	Athabasca Oil Sands Historical Research Project (3 volumes) (at print)
15	ME 3.4	Climatology of Low Level Air Trajectories in the Alberta Oil Sands Area (at print)
16	ME 1.6	Feasibility of a Weather Radar near Fort McMurray, Alberta (at print)
17	AF 2.1.1	Survey of Baseline Levels of Contaminants in Aquatic Biota of the AOSERP Study Area (at print)
18	HY 1.1	Alberta Oil Sands Region Stream Gauging Data Compilation (in preparation)
19	ME 4.1	Sulphur Dioxide Concentrations at Ground Level (in preparation)
20	HY 3.1.1	Evaluation of Organic Constituents (in preparation)
21		AOSERP Second Annual Report, 1976-77